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Media Multitasking at Home: A Video Observation Study of Concurrent TV and Mobile Device Usage

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ABSTRACT

Increasingly people interact with their mobile devices while watching television. We evolve an understanding of this kind of everyday media multitasking behaviour through an analysis of video data. In our study, four households were recorded watching television over three evenings. We analysed 55 hours of footage in which participants were watching the TV. We found that mobile device habits were highly variable between participants during this time, ranging from 0% to 23% of the time that the TV was on. To help us understand this variability, participants completed the Media Multitasking Index (MMI) questionnaire. Results showed that participants with a higher MMI score used their mobile device more while watching TV at home. We also saw evidence that the TV was being used as a hub in the home: multiple people were often present when the time the TV was on, providing a background for other household activities. We argue that video analysis can give valuable insights into media multitasking in the home.

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

Author Keywords

Media multitasking; mobile; television; in the wild; video observation; dual screen; multitasking; task switching

INTRODUCTION

In recent years, using mobile devices while watching television has become a common activity [11, 30, 2]. This concurrent use of multiple media is known as media multitasking. In the UK, communications regulator Ofcom found that 53% of UK adults reported that they regularly media multitasked in 2013 [25], and a 2014 report showed that 99% of adults media multitask at some point during the week, for an average of 2 hours and 3 minutes every day [26]. Multitasking in our living rooms may not have safety implications as in aviation [9, 20] or driving [6], or be directly detrimental to productivity as in workplace

environments [22], but nonetheless this changing behaviour is of interest to a number of groups. TV networks wish to retain their audiences by increasing engagement. Content producers want to create better TV experiences for viewers. Advertisers will want to know whether viewers are switching to their mobile devices during breaks as a way to avoid adverts.

Studies conducted to better understand the prevalence of media multitasking behaviour have typically relied on self reporting from participants (e.g. [11, 29, 36, 37]). However, it is possible that people are poor at estimating just how much time they are spending on digital devices and so misrepresent the extent to which they media multitask. In response to this, a small number of observational studies have also been conducted, for instance using direct observation [38] or sensor-based telemetry [13]. While these methods are more accurate than self-report data, fine-grained video data has the potential to offer a more detailed and nuanced impression of behaviour in situated contexts (e.g. [3, 28]).

In this paper, we used video observation to establish a detailed and accurate understanding of mobile device usage and TV consumption in the home. To do this, we recorded the behaviour of four households over a 72 hour period. Before describing the results of this video observation study, we review related prior research on media multitasking.

RELATED WORK

A number of previous studies have investigated media multitasking behaviours and habits, often using self reporting methods such as surveys [11, 27, 29], diary studies [11, 29, 36, 37], and interviews [36]. Such methods facilitate the collection of large amounts of data, giving a general view of many peoples' media multitasking behaviours and habits. However, self-reported data can be inaccurate and lack granularity. This has led to a need for observational studies to be performed to obtain an accurate view of everyday media multitasking.

In order to better understand when people used their devices while watching TV and exactly what they were doing, Voorveld and Viswanathan [38] conducted an analysis of observational data obtained by directly observing participants from the USA. They found that media multitasking was most prevalent when watching sport and channel surfing, during morning and afternoon, and when individuals were watching television alone. Observations were made every 10 seconds to give a fine-grained view, but were not video recorded and so could not be played back for further post-hoc analysis. Activ-

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ities performed on mobile devices were also not recorded in detail.

Another situated study was performed by Holz et al. [13]. They used a device logging system installed on participants' phones and tablets. Various information was logged, including apps launched and websites visited. This was cross-referenced with the TV programme being watched at the time, which was established using audio fingerprinting. It was found that although the majority of device usage was unrelated to the programme being watched, device usage did differ based on the type of show being watched. Furthermore, device usage seemed to correspond to the events in the show. For example, Holz et al. found that when people were watching crime dramas they tended to use their devices less often towards the end of the programme, presumably because the plot becomes more engaging as it reaches the finale. While this study also gave a very fine-grained view of device usage, it was not video recorded and so the physical behaviour of participants could not be studied to verify what they were doing. For example, mobile device usage was inferred based on application logs. However, without additional observational video data it is difficult to establish whether the participant was actively interacting with the device or whether it had been put aside.

Rooksby et al. [31] used an approach in which device logs were complemented by video observations to identify periods of media multitasking. In this study, parallel TV and device usage was inferred through a device logging system. These logged events were then augmented with an analysis of video observation data. This work was further expanded on [32], but the results focus more on the social implications of how media multitasking affects home life, presented as a small number of vignettes. Furthermore, the participants had to manually turn on the cameras every time they wished to record data, meaning naturalistic data may have been omitted and the fact they were being recorded would have been fresh in their minds.

While the research by Holz et al. [13] and Rooksby et al. [31] is valuable in establishing media multitasking habits in the home, it leaves open an important question of what drives these behaviours. Is it the case that media multitasking behaviour reflects situational factors, such as becoming bored with the television programme or wanting to look up some relevant information, or is it that some people are more inclined to media multitask than others?

Ophir et al. [27] argue that a person's propensity to media multitask is not driven by situational levels of engagement but more reflects a stable individual trait — some people just prefer to media multitask while others do not. To support this claim, Ophir et al. developed the Media Multitasking Index (MMI), a measure used to establish individual media multitasking preferences. Research using the MMI has investigated cognitive differences between media multitaskers [1, 18, 19]. However, little research has been done to investigate this specifically in the context of concurrent TV and phone usage in the home. In other words, are those people that self-report a high MMI actually more inclined to use a device while watching television?

Household	Duration
A	19:07:52
B	07:23:05
C	17:48:07
D	10:04:49

Table 1: Total duration TV was turned on, by household.

The study presented here further investigated individuals' media multitasking behaviour through means of video observation over three evenings. Two surveillance cameras were used. One recorded participants' seating areas and televisions to allow for a greater understanding of physical behaviour and other non-phone and tablet tasks that may occur, and another recorded the television to allow us to see when the TV was turned on and what was being watched. The participants also completed an MMI questionnaire to measure general media multitasking preferences.

METHOD

Participants

Five households were recruited through opportunity sampling. Each household was required to have a dedicated TV set. At least one person in each household was required to watch TV regularly (at least 1 hour evening), who was also required to have a smartphone as their primary device. Households were paid £75 (~\$94 USD) for three evenings of continuous participation.

Household A consisted of a male and female couple, aged 67 and 56 respectively, living in a house in Worcestershire, England. Their TV was located in their living room.

Household B consisted of three cohabiting professional females aged 26, 27, and 29, living in a shared flat in Oxford, England. Their TV was located in their living room area, which adjoined the kitchen and dining area.

Household C consisted of a male and female couple, aged 58 and 59 respectively, living in a house in Worcestershire, England. Their TV was located in their living room area, which adjoined the kitchen and dining area.

Household D consisted of two parents (39 and 45 years old) and their three children (17, 12, and 9 years old) living in a house in Oxford, England. Their TV was situated in their living room.

The final household, **household E**, consisted of two parents in their thirties and their three young children (all under 8 years old) living in a house in Worcestershire, England. Their TV was situated in their living room. Due to technical issues, large portions of the data collected from this household was unusable. For this reason, household E was excluded from this study. The mean age of the remaining participants was 37 ($SD = 19.88$).

Materials

For each household participating, a small mains-powered surveillance camera was used to record a view of the TV for the purposes of programme detection, and another identical camera was angled towards the seating area to record

Participant	Age	Time present when TV on (% of TV on time)	Device use while present (% of time present)	Mean time per use	Number of uses	Uses per hour of time present	MMI
A1	67	17:27:05 (91.22%)	00:51:12 (4.89%)	00:06:24	8	.46	2.27
A2	56	17:30:05 (91.48%)	02:24:02 (13.72%)	00:13:06	11	.63	2.82
B1	27	04:41:28 (63.53%)	00:40:46 (14.48%)	00:02:24	17	3.62	2.7
B2	26	04:04:10 (55.11%)	00:40:24 (16.55%)	00:01:27	28	6.88	4.02
B3	29	02:02:41 (27.69%)	00:05:47 (4.72%)	00:00:58	6	2.93	2.16
C1	58	08:04:50 (44.39%)	00:00:00 (0%)	00:00:00	0	0	0
C2	59	11:39:30 (65.49%)	02:39:45 (22.84%)	00:15:58	10	.86	2.63
D1	39	03:14:43 (32.19%)	00:25:52 (13.29%)	00:03:42	7	2.16	2.68
D2	45	01:30:09 (14.90%)	00:05:52 (6.51%)	00:01:57	3	2	1.04
D3	17	03:59:27 (39.59%)	00:00:00 (0%)	00:00:00	0	0	1.18
D4	10	01:22:03 (13.56%)	00:00:00 (0%)	00:00:00	0	0	1.37
D5	12	04:09:30 (41.25%)	00:22:32 (9.03%)	00:11:16	2	.48	6.45*

Table 2: Results for all participants, grouped by household (all times HH:MM:SS). Note: value marked * denotes anomalous value removed from analysis.

the participants themselves. Video footage was recorded onto micro SD cards. Participants were expected to use their own dedicated televisions for viewing; this study did not record viewing on other devices.

The study utilised a pre-session questionnaire to collect demographic and technology usage data, and the Media Multitasking Index questionnaire [27] to indicate individual media multitasking preferences in general.

Ethical considerations

The presence of surveillance equipment in people's homes presented some ethical and privacy issues. While ethical clearance was given to recruit households with participants under the age of 18 with parental consent, it was possible that visitors under the age of 18 could become part of the study. It was also possible that adults could unknowingly participate. For these reasons, each household was required to display a poster informing visitors of the study taking place in a prominent position near the property entrance.

Procedure

The study took place in participants' homes, wherever their TV was situated. Once participants were recruited, a suitable time was arranged with them for a researcher to visit their property and install surveillance cameras. Clocks across all devices were also synchronised. During this session, the participants were shown the information sheet and given the opportunity to ask questions, then asked to sign a consent form. Finally, they were asked to fill in the questionnaire about demographics and technology usage. Once everything was set up, three evenings' worth of data were logged. These were consecutive evenings where possible, though as some participants said they would not be in the house during that time, evenings were not necessarily consecutive. A time was also agreed for the researcher to collect equipment and pay the participants.

RESULTS

TV watching and device usage

In total, 24 hours' worth of footage for each camera was collected per household, resulting in a total of 192 hours

of footage (96 hours the seating cameras and a further 96 hours for the TV camera). The cameras automatically split the footage into consecutive 30 minute sections. As this study is only concerned with behaviour during TV time, the sections showing the TV were first reviewed in order to discard sections where the TV was turned off. The corresponding footage of the seating areas were also discarded for these times. Once all of the sections with TV activity were identified, the corresponding clips were combined into a one file per evening to keep file sizes manageable - one file for the camera looking at the TV and one for the seating. Both video feeds for each evening were then synchronized and coded using Chronoviz¹. During the coding process, the video was first annotated to show when the TV was on, then all further codes were performed focusing on these periods. During these subsections, the video was annotated to show when each participant was present and when they were using any mobile devices. Further to this, any other notable or interesting events were also annotated, such as use of on-demand services.

The total amount of time participants' TVs were turned on across all households was 54:23:53. This equates to about 57% of the total video recordings. As can be seen in Table 1, there was considerable variability in the total amount of time that the TV was on in each household (*range*: 07:23:05 - 19:07:52).

Results for individual participants can be seen in Table 2. It can be seen that for individual participants, mean total time present when the TV was on was 07:45:15 ($SD = 07:15:56$), mean total device usage when present was 00:46:36 ($SD = 00:48:38$), and mean number of uses was 7.33 ($SD = 8.19$). It can also be seen in Table 2 that there were large individual differences in media multitasking habits between participants. Some participants did not use their devices at all (C1, D3 and D4) while others used their devices for nearly a quarter of the time they were watching (C2). Furthermore, some participants favoured shorter, more frequent uses while others exhibited fewer but longer uses.

¹<http://www.chronoviz.com/> [Last access 27th October 2016]

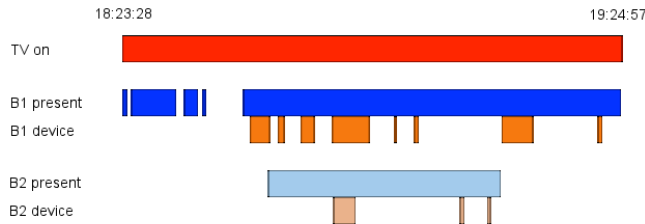


Figure 1: Frequent but short device uses from household B.

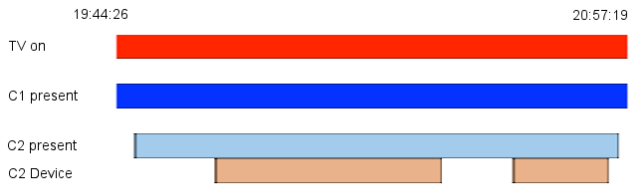


Figure 2: Long but infrequent device uses from household C.

To illustrate some of the differences in media multitasking strategies that were observed, we focus in on two participants with the highest percentage of TV time spent using their devices — these were participants C2 and B2. Participant B2 used their device 28 times for an average of 1 minute and 27 seconds, at a rate of .115 uses per minute, whereas C2 only used their device 10 times, but for an average 11 minutes and 16 seconds at a rate of .014 uses per minute. This can be seen in Figure 1 and Figure 2 respectively, which shows a snapshot of behaviour over a ~1 hour period. However, these individuals did not necessarily sustain the same usage pattern uniformly over the course of their viewing.

Device usage and MMI score

We next consider the relationship between MMI score and total device usage (as a percentage of time participants are present while the TV is on), and between MMI score and device uses per hour. One participant was removed from these analyses due to misunderstanding the MMI questionnaire, leading to an artificially high value. Across the remaining sample of 11 participants, mean MMI score was 2.08 ($SD = 1.1$). Figures 4 and 3 are scatterplots showing the relationship between MMI and time using device and device uses per hour. As can be seen in these figures, participants who had a higher MMI score tended to use their devices for longer periods in total when in front of the TV ($r^2 = .60$), and use their devices more frequently ($r^2 = .48$). Statistical analyses support these observations, showing that MMI score was a significant predictor of time spent using devices in front of the TV, $F(1, 9) = 13.66, p = .005$, and number of devices uses per hour $F(1, 9) = 8.36, p = .018$. In other words, MMI scores were predictive of people's actual observed media multitasking behaviour at home.

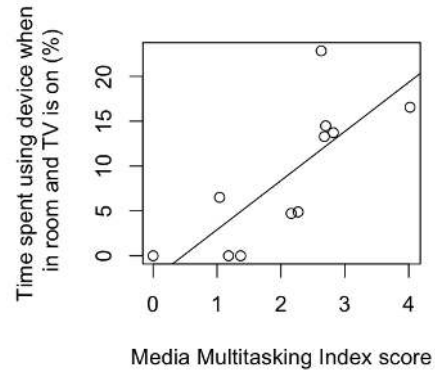


Figure 3: Scatterplot of device usage time against MMI.

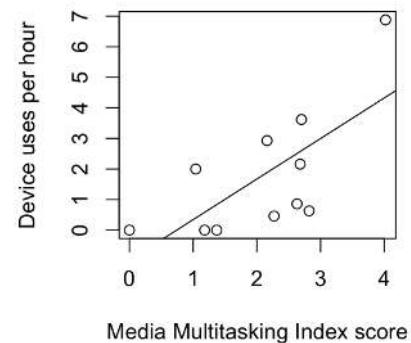


Figure 4: Scatterplot of device uses per hour against MMI.

The TV as a meeting point

Previous literature has shown how the living room and television are used as a meeting place where family and friends gather to be with one another, both to watch programmes together and also to do other tasks while not actively watching [15, 17, 8]. Figure 5 shows some examples of participants using the TV as a background to other activities performed together. Times when there were more than one person present while the TV was on accounted for 28:59:13 (53% of total TV time) across households.

Three of the households were recorded completing some kind of work in front of the TV. Participant A2 was recording completing some accounting work (see Figure 6a), B1 and B3, both teachers, were recorded marking work (see Figure 6b), and the children from household D were recorded doing homework (see Figure 6c).

DISCUSSION

The results of this study revealed large individual differences in concurrent TV watching and device use habits between participants. Some participants were frequent device users, while others used no devices whatsoever. Looking at the demographic make-up information of the households, the household made of females in their late 20s (household B) recorded the largest proportion of concurrent mobile device usage while



(a) Wrapping a present.



(b) Sleeping.



(c) Knitting.



(d) Reading together.

Figure 5: Participants performing tasks in front of the TV with others present.

watching TV. This may be in line with expectations that millennials use more technology than older people [7]. To further understand this, we examined their domestic circumstances, and found that two of the participants had partners that lived in different cities, whereas all of the other households consisted of couples or children. It is possible that this increased usage could be through messaging their partners. This is supported by the high number of uses recorded, which supports the type of phone checking pattern resulting from asynchronous communication.



(a) Participant A2 doing paperwork, while A1 watches TV.



(b) Participant B1, a teacher, marks work in front of the TV, while B2 uses her phone.



(c) Child from household D doing homework.

Figure 6: Participants working in front of the TV.

The MMI questionnaire asks participants to assess their general multitasking preferences across a range of media. Our results show that MMI score was a good predictor of actual media multitasking behaviour. It is interesting to note that the MMI scores of participants in our study were considerably lower than that reported in previous studies that used the MMI — mean MMI score for our participants was 2.08, compared to 4.38 in [27], 3.82 in [21] and 4.07 in [1]. This difference in MMI scores between studies is most likely due to our sample of older participants, compared to the participants in previous studies, which were mainly college students in their early 20s. Both media multitasking and general multitasking has been found to be less common among older generations [7, 10], which would explain this discrepancy. In general, our results suggest that the rate of media multitasking in the home might vary considerably between households.

Different patterns of device usage were observed, ranging from fewer uses lasting for long periods, to many short uses. This raises interesting questions as to how media multitasking is defined. We observed multitasking behaviour at different points on the multitasking continuum [35]. Frequent, shorter uses could be considered instances of concurrent multitask-

ing, where two tasks are being performed simultaneously (e.g. talking and driving). On the other hand, longer uses with fewer switches could be considered instances of sequential multitasking, where only one task at a time is being actively performed before switching to the other task. This means that when the user is purely concentrating on their device, the TV is likely blurring into the background and they stop following what is happening on the TV. Indeed, in our data there were many occurrences of the TV on in the background while the participants were engaged in other activities (e.g. those shown in Figure 5d and Figure 6b). Such nuances may be difficult to convey when using self-reported methods or log analysis to establish how prevalent media multitasking really is, which may call into question the veracity of such methods — simply asking participants if they use their phones and tablets while watching TV may not give a full picture of their behaviour.

The impact of the types of media multitasking we observed should also be considered. It is widely accepted that humans have limited cognitive resources, and so to perform two tasks concurrently they must be interleaved [23, 5, 34]. This results in switch costs, which can impede performance [24]. It may be that negative effects also transfer to the TV domain, for instance in terms of reduced engagement [12]. With regard to processing media messages, we can look to the Limited Capacity Model of Motivated Mediated Message Processing (LC4MP) which attempts to explain such cognitive limitations specifically in relation to mediated communication, such as TV watching [16]. Furthermore, it has also been shown that media multitasking specifically can also have detrimental effects, for instance when attempting to work in front of the TV [4, 19], and there is evidence to suggest that those who media multitask the most are often the worst at it [27].

Our data showed that of the entire time the television was on across households, more than one person was present for at least half of the time. In line with prior research, this shows that the television was very much a meeting point for the households in this study [15, 17, 8]. Watching TV was frequently a social activity, and in addition to coming together to watch programmes together, the participants would leave the TV on while doing other tasks seemingly just to be together. This suggests that although the television landscape has changed and fragmented, people still value the social aspect of sitting together whether or not they are watching TV together. This is supported by the findings of Kubey [14], who found that family viewing is associated with a more challenging, cheerful, and sociable experience than viewing alone. Furthermore, social interaction has also been found to be a motivation for television viewing [33].

LIMITATIONS AND FUTURE DIRECTIONS

This study has described an analysis of video data that gives an interesting snapshot of daily mobile device use in front of the TV. This has allowed these media multitasking moments to be isolated and analysed to give a better understanding of how often and how long they occur in the home. Due to the high level of individual differences observed across participants, and the small sample size, it could be argued that it is difficult to draw strong generalisable conclusions.

However, the results do provide good evidence of a strong link between self-reported MMI and observed device usage.

A number of difficulties were had with the technology. Setting up the cameras was not a trivial task, and at times they malfunctioned resulting in data loss. Furthermore, image quality was lower than desired, which made analysing small movements and glances difficult or impossible. The cameras are intended for basic home surveillance and so were not entirely fit for our purposes, but we were limited by the need to have mains-powered, “set-and-forget” equipment, and by cost.

While the video data can provide a rich perspective into events, it can take significant amounts of time to process and analyse. A number of passes were required to prepare, collate, and synchronise the video files, including a lengthy re-encoding process. The actual video analysis and annotation also required a number of passes in order to make sure each type of relevant behaviour and each participant was accounted for. Nevertheless, our efforts have resulted in a detailed dataset which would be difficult to obtain using alternative methods.

Future work could aim to provide a deeper understanding of these media multitasking moments. It might also be useful to recruit a larger sample to allow for more generalisable patterns of behaviour to be established. However, the resources needed to run such a study, for even small numbers, makes this prohibitive. Furthermore, this study has only focused on viewing in the living room. It would also be beneficial to see how this fits in with content consumption outside of the living room, such as on mobile devices via on-demand services.

CONCLUSION

In this study, we observed four households watching TV for three evenings, with cameras observing both the participants and the television. During the 96 hours of observation across each household, participants’ televisions were turned on for 54.4 hours (57% of the time), with a mean of 13.6 hours. Our results suggest that viewing and device usage habits for individual participants were highly variable. Some participants watched a lot of TV while others watched less. Some participants frequently used their mobile device while other did not use devices at all. MMI was found to be a good predictor of observed media multitasking, taking into account both total device usage and the number of uses, suggesting that people who media multitask with their phone and TV probably do so with other media too. We also observed differing patterns of device use in front of the television, which could be classified at different points on the multitasking continuum.

Our observations confirmed a common theme in prior studies that the TV has a social function in the household. We observed that for 53% of the total time the TV was turned on, more than one person was present. The TV acted as a household hub, with participants gathering around it even when focusing on other tasks, such as work, using mobile devices, and reading. This suggests that although it is changing, the TV remains a focal point for family life in the home.

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